CHAPTER 3

THE UNDERGRADUATE EXPERIENCE IN SCIENCE, MATHEMATICS, AND ENGINEERING

To maintain and improve its standard of living, the United States needs a citizenry and workforce informed in science and engineering. Higher education is essential to this goal, but completion rates of undergraduate study in these fields are unequal—women and minorities except for Asians are underrepresented compared to their presence in the population. This chapter examines aspects of postsecondary education in science and engineering from enrollment to graduation in 2- and 4-year colleges and universities that serve undergraduates and, in some cases, graduate students as well.

This review of the undergraduate level examines changes in enrollment at all institutions of higher education, both of students intending to pursue studies in science and engineering fields and, very briefly, of others. Because of science and technology's increasing importance, more students need more science, mathematics, and engineering courses either to fulfill general requirements or to select as electives. After a consideration of some of the characteristics of the first 2 years of undergraduate science, mathematics, and engineering education at 2-year and at 4-year-and-beyond institutions, this chapter looks at selected patterns in undergraduate science and engineering study and discusses educational environments that influence attrition and retention in these fields.

This chapter notes certain trends in the postsecondary experience of members of racial/ethnic groups underrepresented[1] in science, mathematics, and engineering studies, sometimes in comparison with that reported by undergraduates in other fields. It makes some distinctions between the characteristics of students in associate-level community and junior colleges and those of many first- and second-year students planning from the outset to finish baccalaureate degrees. It analyzes both enrollment distribution and outcomes—the kinds of degrees earned—among target groups and across disciplines and institutions.

Patterns in Undergraduate Education

A decade-long pattern of rising undergraduate enrollment among all students in all undergraduate programs ended in 1993, when 210,965 fewer students enrolled in higher education institutions than in 1992, a 2 percent decline.[2] (See appendix table 3-1.) The numbers dropped for both men and women; however, the numbers of students in all racial/ethnic groups other than white, including foreign students on temporary visas, continued to rise. There were 3 percent fewer white undergraduates in 1993 than 1992 (although 7 percent more than in 1980). Hispanic students increased by almost 3 percent between 1992 and 1993 (about doubling between 1980 and 1993). Although American Indians' numbers went up very little (under 2 percent) between 1992 and 1993, their increase over the 13 years was over 44 percent. Blacks, up less than 2 percent from 1992, increased their numbers by more than 26 percent since 1980. Since 1992, Asians increased by about 4 percent (and by 155 percent since 1980). These trends in enrollment portray a growing diversity within the student population and provide a context for considering the outcomes by discipline areas.

Although *total* first-year enrollment at all undergraduate universities and colleges was down by 17,054 students, *full-time, first-year* enrollment inched up by 0.5 percent from 1992 to 1993. (See appendix table 3-2.) Asian and Hispanic enrollment, which increased by 7 percent and 8 percent, respectively, accounted for most of the overall increase.

First-year, full-time undergraduate enrollment went down from 1980 to 1993; men's enrollment declined more than women's. The drop in white non-Hispanics

[1] According to Bureau of the Census projections, the minority population is on the rise; the workforce as a whole, unlike the population, is less than half female (46 percent in 1994) (Day 1993; U.S. Department of Commerce, Bureau of the Census 1993a, 1993b, 1993c, 1993d, 1993e).

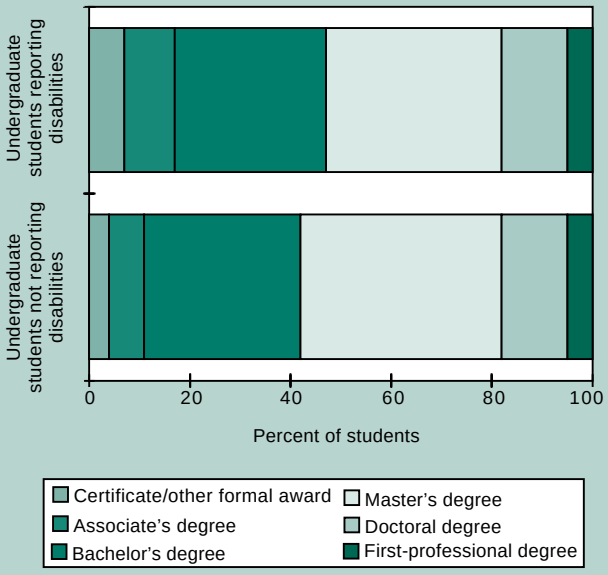
[2] The enrollment data for the complete population of higher education students are from the U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System Fall Enrollment Survey, an annual data collection that obtains information from all accredited institutions of higher education in the country and imputes data for nonresponding units. Like many surveys, these data separate Asians (who are overrepresented in science, engineering, and mathematics in colleges, universities, and the professions) from other minorities. It also often distinguishes between "all institutions," including 2-year colleges and "4-year and beyond." The National Center for Education Statistics, however, does not collect data on student enrollment according to field.

both in numbers and as a share of the first-year, full-time group—from 79 percent of this group in 1980 to 72 percent in 1993—accounted almost entirely for this decline. Numbers of beginning full-time students from nonwhite ethnic subgroups, like minorities in other U.S. population groups, continued to rise: over the 13-year period, Asian/Pacific Islanders went from 2 to 5 percent of this group; Hispanics, from 6 to 9 percent; blacks, up by half a percent to 11 percent.

Six and a half percent of students in 1993 reported having a disability.[3] (See appendix table 3-3.) Undergraduates claiming disabilities ranged in age from less than 18 years old to more than 30. These students had about the same degree aspirations as others. (See figure 3-1.)

Veterans were more likely to have a disability than were nonveterans, and older students were more likely to have a disability than those under age 24. Undergraduates with disabilities were more likely to attend school part time and to go to 2-year institutions than others, who clustered in 4-year-and-beyond universities and colleges. About 6 percent of students majoring in science and engineering had disabilities; so did about 7 percent of those in other fields.

Figure 3-1.
Degree aspirations of undergraduate students by disability status



SOURCE: Henderson 1995b, p. 3.

Some 37 percent of undergraduates received financial aid in 1992–1993. (See appendix table 3-4.) No significant difference is evident between students with and without disabilities in receiving financial aid overall. Greater percentages of students *without* disabilities in hearing, learning, and speech received funding than those *with* such problems. On the other hand, a larger proportion of students with orthopedic, visual, or other health-related disabilities received financial aid than those without them.

Full-Time 4-Year Enrollment

About 75 percent of all students were enrolled full time in 1993, continuing a pattern that had been stable for over a decade. Women and underrepresented minority students were as likely to be attending full time as white males, and over 80 percent of Asians and foreign students were enrolled full time. Women were 52 percent of the students enrolled in 1993 on a full-time basis at 4-year-and-beyond institutions. That year they made up 54 percent of total enrollment at such institutions, up from 51 percent of this group in 1980. (See appendix table 3-5.)

Minorities and foreign students made up 26 percent of full-time enrollment at baccalaureate-level-and-beyond colleges; underrepresented minorities, 18 percent, an increase from 14 percent in 1980.

The First 2 Years

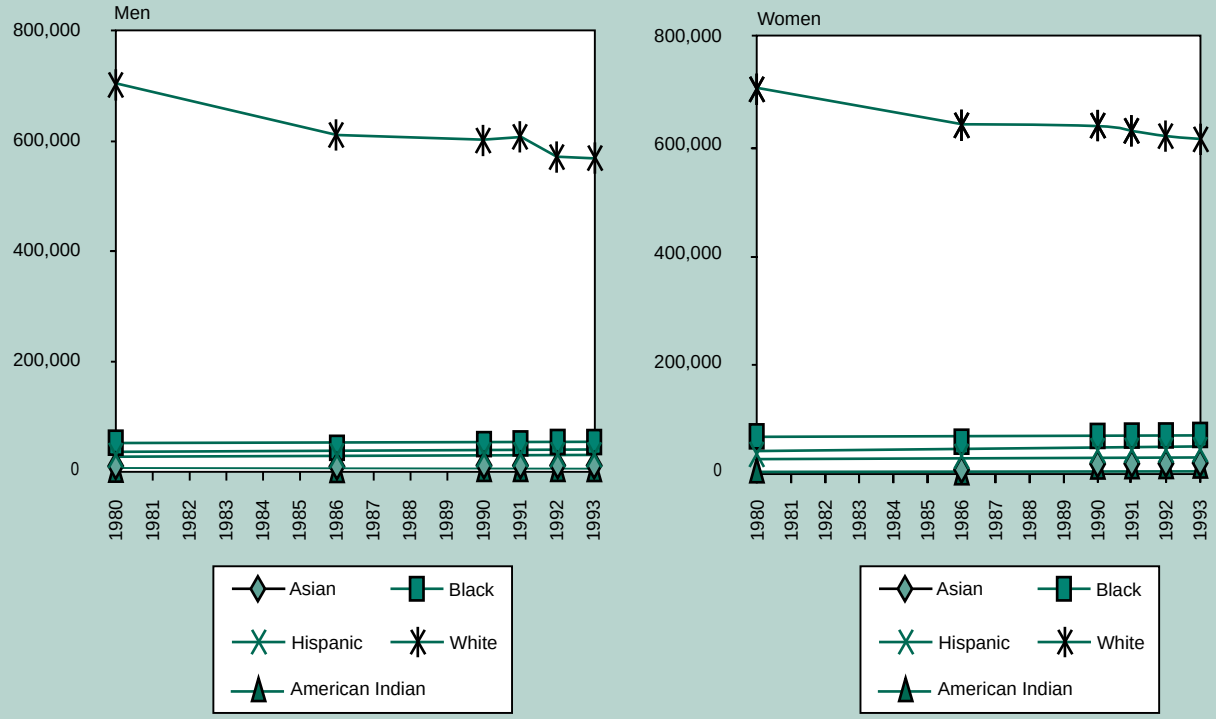
First-Year Enrollment

Trends in enrollment of first-year and full-time, first-time, first-year students are important indicators for future enrollment in higher education. They not only reflect to some extent the size of the population traditionally entering college, but they also reveal changing patterns among students' higher education enrollment choices. The number of full-time, first-year students at 4-year-and-beyond institutions, a number that fluctuated during the 1980s, remained 5 percent lower in 1993 than it had been in 1980. (See appendix table 3-6 and figure 3-2.) This trend parallels an overall decline since 1981 in the 18- to 24-year-old U.S. population (U.S. Department of Commerce, Bureau of the Census 1995).

The full-time, first-time students enrolled in 1993 remained 5 percent below 1980 levels. A slight—1 percent—increase in this cohort between 1992 and 1993 comprised about two-thirds women and one-third men. Women were 53 percent of first-time, first-year students in 1993, up only slightly from 52 percent in 1980. Since then, however, minority enrollment has increased. More than twice as many Asian students were among first-time students enrolled in 1993 than 13 years earlier, going from 2 percent of that group in 1980 to 5 percent in 1993.

[3] Other National Center for Education Statistics data offer selected information about postsecondary students with disabilities. The U.S. Department of Education's National Postsecondary Student Aid Study in 1993 asked undergraduates and graduates if they had a functional limitation, disability, or handicap. Each survey participant responded to a set of six separate questions about particular disabilities. The National Center for Education Statistics weighted responses to produce national estimates for the student population. (See appendix A Technical Notes.)

Figure 3-2.
Full-time, first-time, first-year enrollment of minority students at 4-year institutions, by sex and race/ethnicity: 1980–1993 (selected years)



See appendix table 3-6.

In 1993 the numbers of men and women enrolled as full-time, first-time, first-year students at 4-year-and-beyond institutions had increased slightly over the previous year, but fewer male foreign students on temporary visas were enrolled. (See appendix table 3-6.) The number of full-time, first-time, first-year Hispanic students at 4-year-and-beyond institutions rose by almost 3 percentage points over the 13-year period to 8 percent of this cohort. The numbers of blacks enrolled for the first time continued to increase in 1993 following some intermediate decreases in the mid-1980s. Black students were 10 percent of first-year students in 1980 and 11 percent in 1993. Although the numbers remain small, some 2,000 more American Indians were in college for the first time in 1993 than 1980.

First-Time, Full-Time College Students

Parents' income and education influence their children's college attendance and success. Studies of first-year, first-time students found that Asian students were more likely than others to have parents with incomes over $100,000 (19 percent had incomes that high), followed by whites (18 percent). (See appendix table 3-7.)[4] It is not surprising that students from these racial groups were most likely to receive financial help from their parents. About 68 percent of white and Asian students received $1,500 or more from parents or relatives, whereas fewer than half of students from underrepresented minorities had such aid. Seventeen percent of first-year students intending science and engineering majors had parents with incomes over $100,000. Only 6 percent of black students, 9 percent of Hispanics, and 11

[4] Every year since 1966, a large sample (for example, in 1994, 237,777 students attending a cross section of 461 universities and 2- and 4-year colleges) of first-time, full-time, first-year students have taken this survey. Survey cosponsor (with the University of California, Los Angeles) the American Council on Education provides an invitation list of some 2,700 postsecondary institutions to the Cooperative Institutional Research Program, which solicits them for information on matriculating students. The data gathered are analyzed and published annually as *The American Freshman*, under the direction of Alexander W. Astin. (In a volume concerned with gender issues, however, most references to beginning college students will prefer "first-year" to Astin's term.)

To be included, postsecondary institutions must pay a fee and poll large numbers of their first-year, full-time, first-time students—4-year colleges need an 85 percent response rate; universities, 75 percent; and 2-year institutions, 40–50 percent. The responses are "weighted to represent the national enrollment patterns of the total 1.5 million first-time, full-time freshmen attending some 2,700 institutions of higher education in 1994" (Henderson 1995a [chapter 3], p. 5).

For reasons not well understood, 2-year schools participate at a much lower rate than baccalaureate- and graduate-level institutions. In 1994, only 24 of 950 2-year schools returned surveys, compared with 437 4-year-and-beyond institutions (personal communication, William S. Korn, 1995). Because of this low response rate, *Women, Minorities, and Persons With Disabilities in Science and Engineering* in general uses only Cooperative Institutional Research Program data on 4-year-and-beyond universities and colleges. When 2-year data are included, a footnote so indicates.

percent of American Indians had parents with incomes that high. (See appendix table 3-7.) The parents of about 33 percent of black, 26 percent of Hispanic, and 20 percent of American Indian students had incomes under $20,000.

The educational attainment of parents of students from underrepresented groups has increased since 1984. Because favorable home environments tend to lead to better patterns of educational achievement, this seems a hopeful trend.[5] Black students' mothers had the greatest increase in years of formal education. The percentage earning only a high school degree or less decreased from 53 percent in 1984 to 36 percent in 1994. An even greater increase occurred among black students whose mothers had earned a college degree or more. In 1984, that number was 23 percent. By 1994, it had increased to 34 percent, about level with American Indians' students' mothers and well above Hispanics'. White students planning a science and engineering major reported parents with the most extensive educations—over half of their parents had a college degree or higher. The proportion of parents with limited educational backgrounds dropped.

Percentages of students whose parents had college degrees or more also rose. The proportion of Hispanic students whose mothers had baccalaureates or more went from 19 percent in 1984 to 24 percent in 1994; their fathers, from 23 percent to 31 percent. (See appendix table 3-8.) In 1984, 22 percent of black students reported that their fathers had earned baccalaureates or more. That percentage increased to 30 percent in 1994. For these groups, the percentages whose parents had high school diplomas or less dropped: for fathers of black students, the drop was from 60 percent in 1984 to 46 percent in 1994; for fathers of Hispanic students, the drop was from 60 to 51 percent. In 1984, 60 percent of Hispanic students' fathers had no education beyond high school (64 percent reported that their mothers' schooling stopped there also). In 1994, these numbers dropped to 51 percent and 54 percent, respectively.

Grades in high school can be an important predictor of success in college. Full-time, first-year women students were more likely than men to have earned high grades in high school—36 percent of women compared with 26 percent of men have grades of A–A+. (See appendix table 3-7.) Students planning science or engineering majors have higher high school grades than others. Within this group, the women reported higher grades than the men—47 percent of women and 43 percent of men had average grades of A in high school. Although the gender difference in grades persisted, the differences between women and men were less than those among all students.

The pattern of higher grades for women, which prevails overall in college as well as high school, is also evident among science and engineering majors. For example, nearly two-thirds of female mathematics or computer science majors achieved a grade point average of B or higher, compared with fewer than half of the men who majored in those fields. In engineering, a higher percentage of women (63 percent) than men (49 percent) reported a B average or better. By field and by race/ethnicity, the distribution of college grades varied considerably. (For further information, see NSF 1994, p. 50.)

Asians (49 percent) were the most likely to report an A average in high school; blacks (17 percent) were the least likely. About one-third of white, Hispanic, and American Indian students had an average grade of A.

Prospective female first-year mathematics and science majors had taken nearly as much high school mathematics as had their male counterparts in 1994 (98 percent of both genders completed at least 3 years). Women would-be majors, however, still took less physical science and computer science and more biology in high school than their male counterparts. (See appendix table 3-9.)

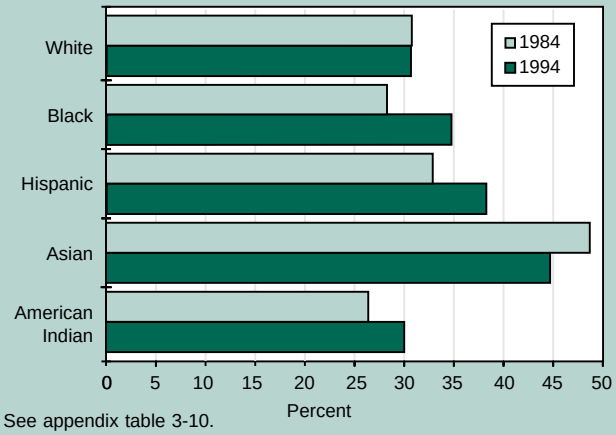
All racial/ethnic groups also increased the amount of mathematics studies; between 95 percent and 99 percent studied the subject for at least 3 years. In contrast to the pattern in mathematics study, all groups except whites and American Indians took less physical science in 1994 than in 1984. All groups except blacks, however, took more biological science. Asians and whites took less computer science in 1994 than in 1984. By 1994, the percentages of all groups studying computer science almost leveled out. (See appendix table 3-9.)

Choices of major showed distinct differences across gender and racial/ethnic groups; although less in 1994 than 1984, the differences remained. About 31 percent of white first-year students intended science or engineering majors in 1984 and 1994; however, more white women (26 percent compared with 23 percent) and fewer white men (36 percent compared with 40 percent) were choosing those fields than was the case a decade earlier. Fewer first-year Asian students (45 percent compared with 49 percent) planned on science or engineering in 1994 than 10 years earlier; Asians nonetheless remained the racial/ethnic group having the highest proportion so choosing. A greater percentage of blacks intended science and engineering majors in 1994 than 10 years earlier. The percentage of American Indians planning a major in these fields went from 27 percent to 30 percent. (See figure 3-3.)

In all cases, men were more likely than women to plan such majors. More than half of first-year Asian men students (in 1984, 60 percent; in 1994, 53 percent) in comparison to somewhat more than a third of first-year Asian women (37 and 36 percent, respectively) planned science or engineering majors. (See appendix table 3-10.)

[5] Since 1985, one parent of all doctoral degree earners except American Indians has been likely to have earned an advanced degree as well as a bachelor's (Smith and Tang 1994, p. 101).

Figure 3-3.
Percentage of freshmen who chose science and engineering majors, by race/ethnicity: 1984 and 1994



See appendix table 3-10.

Not all prospective science or engineering majors are committed to careers in those fields. For example, in 1994 under a quarter of first-year students planning a major in science or engineering planned engineering careers; in 1984, nearly a third had chosen engineering. Of the men planning a major in science or engineering, 41 percent in 1984 chose engineering in contrast to 14 percent of the women; in 1994 the percentages had dropped to 35 percent and 11 percent, respectively. And 11 percent of these majors thought in 1984 that they would eventually become computer programmers (5 percent a decade later). The largest percentage of a racial/ethnic group intending an engineering career is Asians (19 and 13 percent in 1984 and 1994, respectively). Among freshmen intending a science and engineering major, 5 percent planned careers as research scientists in 1984, 7 percent in 1994. (See appendix table 3-11.)

About 1 in every 11 entering full-time, first-year students in 1994 reported at least one disability (Henderson 1995a, p. 7).[6] About the same percentage of freshmen with disabilities at baccalaureate-level-and-above institutions chose science and engineering majors as ones without disabilities. Within those fields, the largest percentage of students with disabilities chose the social sciences (over 10 percent); the smallest (under 8) chose engineering. First-year students who planned majors in science or engineering were more likely to have visual impairments than to have other disabilities. (See appendix tables 3-12 and 3-13.) Between 1988 and 1994, more students were claiming learning disabilities both in absolute numbers and as a percentage of the group with disabilities. (See figure 3-4.)

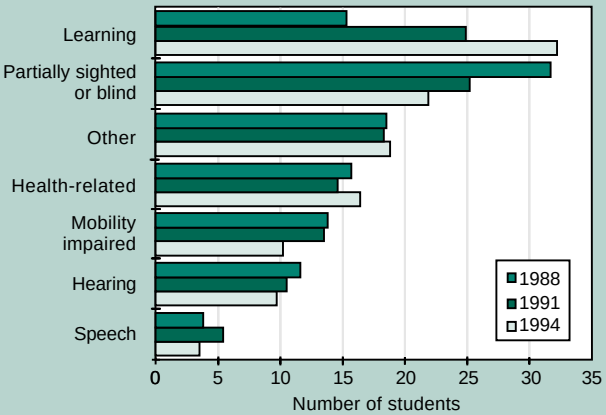
Freshmen with disabilities were more likely to enroll in 2-year colleges (41 percent) than other freshmen (33 percent); the latter were more likely to be found in universities (25 percent) than were students with disabilities (18 percent) (Henderson 1995a). Although the personal and family backgrounds of students with and without disabilities were largely similar, the former tended to be older when they entered college than traditional freshmen enrolling right after high school. Fifty-two percent were male and 42 percent were white men, making both groups overrepresented among students with disabilities.

Disability status of students did not appreciably affect their interest in particular fields. On several other traits, students with disabilities differed from others. Students with disabilities were more likely to see themselves as above average in creativity and stubbornness and less likely to think themselves above average with regard to self-confidence or academic ability. (See figure 3-5.) This pattern of shaky self-esteem among freshmen with disabilities is similar to that reported by Seymour and Hunter (see box on page 32); on the other hand, students with disabilities rated themselves as more creative and artistic than others (Henderson 1995a, p. 24).

The Role of 2-Year Institutions

Two-year institutions often have specialized missions. In pursuit of their role in postsecondary education, most community colleges serve several roles: they prepare students academically to transfer to baccalaureate-level institutions and provide vocational, technical,

Figure 3-4.
Full-time college freshmen with disabilities, by type of disability: 1988, 1991, and 1994



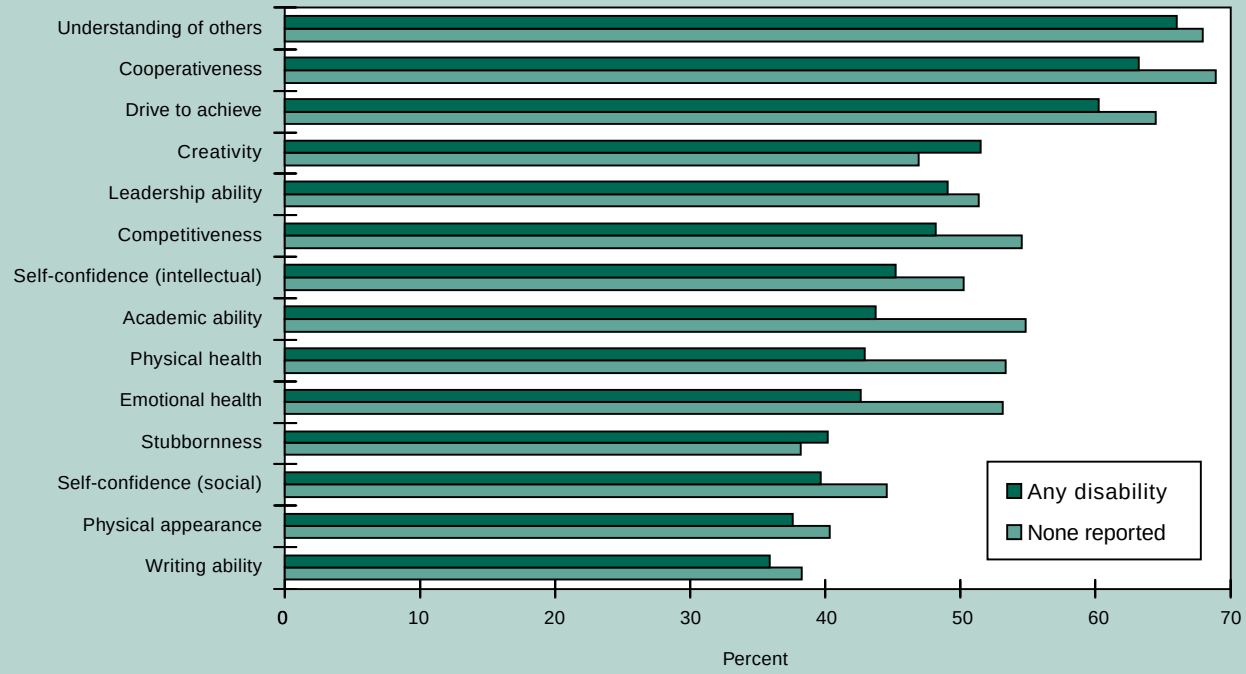
NOTE: Because of multiple responses, percentages may total more than 100. Data from 2-year institutions are included.

SOURCE: Henderson 1995a, p. 9.

[6] The Cooperative Institutional Research Program, which has asked a question about disabilities on several occasions since 1978 (it now so queries students every other year), asked in 1994 "Do you have a disability? (Mark all that apply.)" The choices were "none, hearing, speech, orthopedic, learning disability, health-related, partially sighted or blind, and other" (Astin et al. 1995, p. 106). (See also footnote 4.)

The fact that more than three times as many students responded affirmatively to this question in 1994 than did in 1978 may reflect different reporting policies rather than indicating a three-fold jump in the population of students with disabilities: "Students who respond to [the disability] question are self-reporting their disabilities…. It is unknown how long the students have lived with their conditions or whether they have been through a formal diagnostic process" (Henderson 1995b, p. 6).

Figure 3-5.
Full-time college freshmen who felt they were above average in ability ratings: 1994



NOTE: Data from 2-year institutions are included.

SOURCE: Henderson 1995a, p. 22.

continuing,[7] and remedial education, as well as offering options for community service.

Community colleges and other associate-level institutions operate in every state and enroll half of the students who begin college in the Nation. Since their origins in the early years of the 20th century, 2-year institutions have played a major role in higher education. Most 4-year-and-beyond colleges and universities admit only students who meet certain academic requirements. Two-year colleges have traditionally exercised less selective admissions policies, thereby providing higher education to students who otherwise might have been excluded. Two-year colleges often serve students who cannot pay high tuition, who have to attend part time, and/or whose high school preparation was inadequate (Cohen and Brawer 1989, p. 14).

About one-fifth of the students who attend a 2-year institution eventually go on to a 4-year college or a university (Adelman 1988). Most associate-level institutions have also assumed a special mission in relation to education in scientific and technical fields (Burton and Celebuski 1994). They find that

- "An estimated 725 of the nation's two-year colleges offer engineering and technology classes. About 500 offer science technology courses."
- About one-fifth of all students in 2-year colleges offering engineering technology are pursuing studies in the field.
- "Two-year colleges emphasized the teaching of applied skills slightly more than they emphasized fundamental science and mathematics in engineering technology" (p. vi).

For information on the relation between professional and technical workers, see Barley (1993).

From 1980 to 1992, both the number and the diversity of students attending 2-year institutions increased substantially. (See figures 3-6 and 3-7.) Despite a slight drop in total and full-time enrollment, community colleges continue to attract large numbers of older and part-time students, as well as women, members of racial/ethnic minority groups, and individuals with disabilities. In 1993, enrollment at 2-year facilities, like that at other postsecondary institutions, slipped slightly. Since 1986, women have been the majority of both total and full-time students in 2-year institutions (in 1993, 58 and 54 percent, respectively). (See appendix table 3-15.) Enrollment in 2-year schools is more prevalent among minorities than whites. More than half of American Indian (54 percent) and Hispanic students (53 percent) attend 2-year colleges compared with 44 percent of all students. (See appendix tables 3-1 and 3-15.)

The attendance patterns of the student populations differ between 2-year and 4-year institutions: 63 percent

[7] That is, postsecondary study not *necessarily* leading to a traditional baccalaureate.

Patterns Among American Indian Undergraduates

Data on American Indians in higher education may be unreliable because of students who change their declarations of race/ethnicity after they matriculate.[8] About half of the Cooperative Institutional Research Program respondents who identified themselves as American Indians or Alaskan Natives as first-time students switched their ethnic/racial designation to white, non-Hispanic 4 years later (Pavel and Dey research in progress); however, "those who maintained Indian and Native identity had higher grade point averages and were much more likely to receive a degree than those who 'switched'" (Pavel et al. 1995, p. 44).

Of the nearly 122,000 American Indian undergraduates in 1993, 58 percent were women. Some 63,000 went to 2-year colleges; some 59,000, to 4-year-and-beyond institutions. Their dropout rate is high—9 percent of American Indians studying for baccalaureates earned degrees compared with 24 percent of whites and 33 percent of Asians *(The High School and Beyond Senior Cohort Study (1980–1988),* cited in Wells 1989).

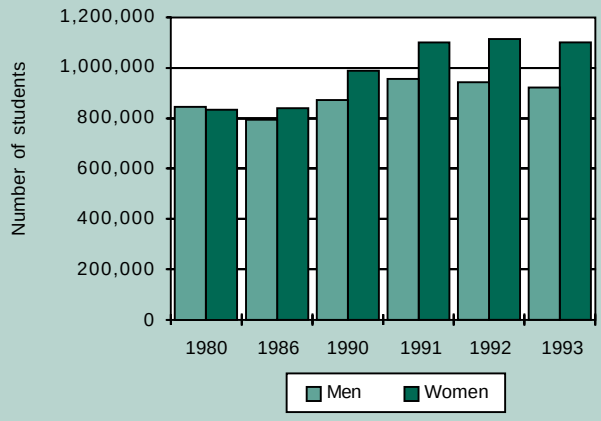
[8] High school and college counselors often encourage applicants to identify themselves as American Indians or Alaskan Natives to increase chances for admission or scholarships (Pavel et al. 1995).

About 14,000 of the American Indians in 2-year institutions enrolled in the tribal colleges that became possible in 1978 with the passage of the Tribally Controlled Community College Act. Nearly all tribal colleges and universities are located near tribal lands, and nearly all are community colleges or technical schools; however, three offer baccalaureate degrees and two, master's degrees. Although each tribal institution is unique, they share certain characteristics:

> Most are governed by boards composed entirely or primarily of American Indians and Alaska Natives; have student bodies that are predominantly American Indian and Alaska Native, and are located in isolated areas.…A primary mission is to reinforce and transmit traditional cultures. All of the institutions offer a practical curriculum geared to contemporary, local needs and are community-service oriented (Pavel et al. 1995, p. 51).

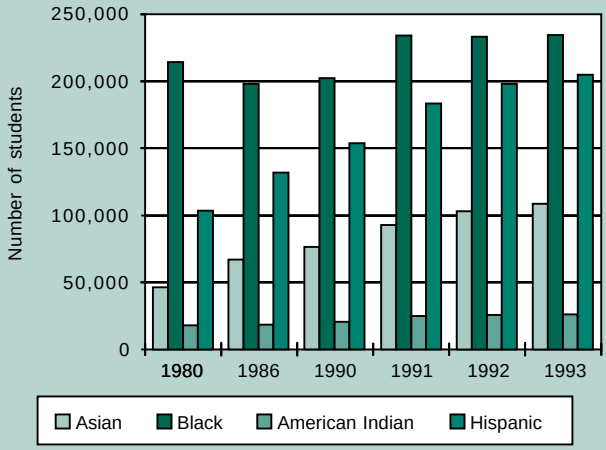
Tribal college graduates earn a mean income of $18,000, much higher than that of the majority of American Indians. About 34 percent of students in tribal colleges eventually transfer to baccalaureate institutions, a number of which offer programs aimed particularly to serve American Indians.

Figure 3-6.
Full-time enrollment at 2-year institutions, by sex: Fall 1980–1993



See appendix table 3-14.

Figure 3-7.
Full-time enrollment at 2-year institutions, by race/ethnicity: Fall 1980–1993



See appendix table 3-14.

in 2-year institutions went part time in 1993, compared with 41 percent in all institutions, and 25 percent in baccalaureate-and-beyond colleges and universities. (See appendix tables 3-5 and 3-15.) Since 1980, the percentage of part-time students has been up slightly in all institutions, in 2-year colleges and in 4-year-and-beyond institutions.

Two-year colleges also play a role in educating many future scientists and engineers. Over a third (39 percent) of the 639,500 total science and engineering graduates in 1991 and 1992 also attended community colleges, and just under a third (30 percent) of that group earned associate degrees. (See appendix table 3-17.) Women baccalaureate graduates were more likely to have attended two-year colleges than men (40 percent as compared with 38 percent). A higher percentage of minority students (39 percent of underrepresented minorities and 48 percent of Asians) than whites (38 percent) went first to community colleges before eventually earning baccalaureates in science and engineering.

Two years after beginning their college or university education, students intending baccalaureates were more likely to have attended continuously than ones aiming for associates. (See appendix table 3-18.) By the end of 2 years, almost half of associate degree seekers had failed to reenroll after an interruption compared to a quarter of would-be baccalaureate dropouts. A greater proportion of black students dropped out of 2-year institutions than did whites or Hispanics, the group with the least attrition at the 2-year level. Most students planning baccalaureates embarked on a continuous enrollment pattern, whereas only one in five students planning associate degrees attended for 2 years without interruption.

After the First 2 Years: Patterns of Students Majoring in Science, Mathematics, and Engineering

College attendance patterns are changing. Only slightly more than half of all enrolled students (both male and female) now follow the formerly traditional pattern of full-time, uninterrupted 4-year attendance (University of Pennsylvania/Institute for Research on Higher Education 1994; NSF 1994, pp. 47–51). Between 47 and 50 percent of students from minority groups follow the continuous pattern, compared with 53 percent of whites.

Students majoring in science or engineering fields are more likely to have followed traditional attendance patterns than students generally, with percentages ranging from over 50 percent to almost 75 percent. Because of their time disadvantage (see box below), many students with disabilities would have liked to attend intermittently; however, financial aid restrictions often mandated full-time attendance.

Students With Disabilities Studying Science, Engineering, and Mathematics: The Time Disadvantage

Many of the problems experienced by persons with disabilities are similar to those of other students in science, mathematics, and engineering; however, the difficulties of the former are magnified by what Elaine Seymour and Anne-Barrie Hunter (in press) identify as a shared "disadvantage of time." [9] Nearly 60 percent of 65 respondents studying at the University of Minnesota's Institute of Technology counted among their difficulties struggles with time issues. These included "problems of pace; speed of learning, comprehension, and recall; temporal disruptions in mental and physical functioning; time-related educational needs; and time expended in dealing with all types of problems" (p. 173).

"By the start of junior year," write Seymour and Hunter, science, mathematics, and engineering "faculty have (on a national basis) effectively engineered the weeding out of between 40 percent and 60 percent[10] (with variations by discipline) of all freshmen (and of larger proportions of women and students of color) who had intended to major in these disciplines" (pp. 75–76).

[9] Their study, *Talking About Disability: The Education and Work Experiences of Graduates and Undergraduates With Disabilities in Science, Mathematics, and Engineering Majors*, analyzed these experiences through the eyes of 47 males and 18 females at the Institute of Technology (Minneapolis). Seymour and Hunter chose these 65 students (plus a small random sample of recent graduates) at this institution for a number of reasons: among them, students with reported disabilities made up a high percentage of such individuals compared to those in other schools of engineering; and both the State and the institution have a record of serving individuals with disabilities better than many others. More undergraduates (44) than graduate students (21) were interviewed; however, responses were similar at both levels.

[10] Percentages based on data from unpublished 1993 Cooperative Institutional Research Program figures (Seymour and Hewitt 1994, p. 37).

Students With Disabilities Studying Science, Engineering, and Mathematics: The Time Disadvantage *(continued)*

Through data gathered in intensive individual and focus-group interviews, *Talking About Disability* notes, as did an earlier study Seymour coauthored,[11] some of the reasons why many undergraduates drop out of science, mathematics, and engineering majors.

The performance scores and graduation rates, both in terms of percentages finishing and of length of study, of individuals with disabilities are similar to those of other science and engineering students in spite of the first group's frequent in-and-out attendance patterns. Further, students with disabilities had often chosen their majors because of "intrinsic interest"—according to *Talking About Leaving*, "the best predictor of persistence" (p. 21).

Undergraduates with disabilities who chose science and engineering majors found "hostile attitudes of science, mathematics, and engineering faculty" to be their most serious problem. In contrast, "There were only a handful of complaints about [other] faculty, most of whom were reported to be cooperative in following the formal accommodation procedure" (p. 66).

Students with disabilities identified tight finances as their next most serious problem, and the effects of disabilities were *third.* A better understanding of the temporal issues common to students with disabilities could help to alleviate some of the problems raised by both faculty gatekeeping and finances. Respondents believed that

> some of the rules by which funds—especially financial aid—are currently awarded or withheld need to be amended to take into account the kinds of problems which many students with disabilities unavoidably face: the need to progress more slowly in their degree program than some other students; to take time out; and to attend school part-time. Attention to these difficulties will[12] involve changes in financial aid regulations at state and national levels (p. 181).

Similarly, "the apparent difficulties [science, mathematics, and engineering] faculty face in trying to distinguish one form of disability from another, in order to decide whether they should allow some relaxation of the moral rules [calling for impartiality] might be alleviated," if [faculty] could understand disability as "essentially, a disadvantage of time" (p. 177).

Instead, many attempt to distinguish between "acceptable" and "unacceptable" handicaps. By trying to apply what they perceive to be fair rules to *all* students rather than by attending to *individual* students' needs, science and engineering faculty members sometimes violate institutional provisions for justifiable exceptions.

Seymour and Hunter conclude that "the greatest problems of accommodation appear to be problems of attitude not architecture; not how to adapt facilities or equipment but the willingness to do it" (p. 166). "Treating everyone alike," they continue,

> that is, in a manner which is in line with the prior educational experience of white male students, has unequal consequences for whole groups of students for whom this treatment is unfamiliar and less appropriate, namely, white women, and students of color of both genders…. Students with disabilities inadvertently challenge the traditional system more than any other group by openly asking for suspension of, or exemption from, some of its moral rules (p. 76).

[11] Seymour and Hewitt, *Talking About Leaving* (1994).

[12] And, many students with disabilities believe, should….

Faculty Teaching Undergraduates

Few women and underrepresented minorities find role models in their science and engineering fields. Among full-time ranked faculty in these fields, women are only 16 percent and blacks, Hispanics, and American Indians combined only 6 percent. (See appendix table 5-27.)

Students Leaving College in General and Science, Mathematics, and Engineering in Particular: Some Causes—And Some Remedies

Persistence is obviously an essential component in successful completion of undergraduate education. Comparisons of 1991 and 1993 enrollment profiles in lower and upper divisions respectively[13] by sex and race/ethnicity, indicate changes in the composition of student groups, changes that would not happen if all groups progressed at identical rates. Although enrollment of all minorities in higher education is up overall, comparison of enrollment by level suggests that underrepresented minorities quit without completing degrees in higher proportions than do white and Asian students. (See appendix tables 3-19 and 3-20.) These figures indicate only general trends, however, and fail to show the important effects of in-and-out or part-time attendance and transfer students. Minority students dropped out between divisions in uneven numbers. Blacks had the highest rate of attrition. Enrollment percentages of white, Asian, and nonresident students rose slightly from lower division (1991) to upper division (1993).

Longitudinal data on science and engineering dropout rates are unavailable, but studies by Seymour and Hewitt, 1994 (see box on page 33), Seymour and Hunter (in press, and see box on page 32), and Steele (1995; see box on page 37) offer some insights on attrition in these fields. Many students who enter college planning to study science, mathematics, and engineering change their plans. An analysis of information from undergraduates on seven college campuses who switched out of such majors—and others who persisted—identified 23 factors influencing such decisions (Seymour and Hewitt 1994). Despite many concerns shared by both men and women, substantial differences by gender suggest that they approach college with different goals and experience their undergraduate education differently.

The students who switched agreed on their top five overall concerns, but men and women differed on the

[13] Lower division students (sometimes called freshmen and sophomores), formally matriculated, have earned fewer than half the number of credits needed to graduate, usually under 60 hours in a 120-hour degree program. Upper division students (sometimes called juniors and seniors) have earned more than half of the necessary credits but have not yet graduated. These categories apply only to baccalaureate students in general and can only suggest changes in the status of particular students.

Text table 3-1.
The top 10 reasons why women switched out of their science and engineering majors and the comparative rankings of men who switched: 1994

	Rank importance among students switching majors		Percentage of students switching majors who cited issue	
	Women	Men	Women	Men
Reasons for choice of science, mathematics, and engineering major prove inappropriate	1	2	91.4	74.2
Poor teaching by science, mathematics, and engineering faculty	2	1	89.2	92.1
Inadequate advising or help with academic problems	3	3	83.9	68.5
Non-science, mathematics, and engineering major offers better education/more interest	4	5	60.2	57.3
Lack of/loss of interest in science, mathematics, and engineering: "turned off by science"	5	4	58.1	61.8
Rejection of science, mathematics, and engineering careers/associated lifestyles	6	11	49.5	37.1
Inadequate high school preparation in basic subjects/study skills	7	8	40.0	41.6
Science, mathematics, and engineering career options not worth effort to get degree	8	7	38.7	48.3
Curriculum overloaded, fast pace overwhelming	9	6	37.6	53.9
Discouraged/lost confidence due to low grades in early years	10	13	36.6	31.5

SOURCE: Seymour and Hewitt 1994, pp. 258–259.

rank of their importance. Nine out of 10 of those who left science, mathematics, and engineering were concerned about pedagogy; however, men and women defined good teaching differently. Even women with good academic records often felt their academic performances were not "good enough," unless they had a satisfying personal relationship with one or more of their teachers. Unfortunately, such relationships were reported to be rare. (See NSF 1994, p. 46, and text table 3-1 for details.)

Striking differences appear among reasons why students from particular ethnic/racial groups left science, mathematics, and engineering. Minority and majority students differed about their reasons for switching. Students of color tended to blame themselves for switching, whereas white students more often pointed to institutional failures. For example, white students complained of poor teaching and curriculum overload more than twice as often as did minority students. Many minority students reported that they had been "…overencouraged to enter technical fields for which they were underprepared." These findings suggest a need for better presentation of what science, mathematics, and engineering majors and careers require. (See NSF 1994, p. 48 and text table 3-2.)

Positive Patterns for Women, Underrepresented Minorities, and Students With Disabilities in Science, Mathematics, and Engineering

Some colleges and universities do better at encouraging women, underrepresented minorities, and students with disabilities to enter—and stay—in undergraduate science and engineering programs than others. Helpful for all three groups are active support groups, encouraging professors, and peer and faculty mentors. (See Fuller 1991; Rosser and Kelly 1994; Fort 1995; Stern and Summers 1995.)

Women

Some institutions graduating large numbers of science and engineering women PhDs are also the origin of women's undergraduate degrees in those fields. Universities granting significant numbers of degrees to women in science and engineering fields between 1989 and 1993 at both the undergraduate and doctoral levels include the University of California, Berkeley; Cornell University (Ithaca, New York); the University of

Text table 3-2.
The top 10 reasons why minority undergraduates switched out of their science and engineering majors and the comparative rankings of whites who switched: 1994

	Rank importance among students switching majors		Percentage of students switching majors who cited issue	
	Minority	White	Minority	White
Non-science, mathematics, and engineering major offers better education/more interest	1	2	36.5	42.0
Reasons for choice of science, mathematics, and engineering major prove inappropriate	2	15	34.6	6.1
Shift to more appealing non-science, mathematics, and engineering career option	3	6	32.7	22.9
Conceptual difficulties with one or more science, mathematics, and engineering subject(s)	4	16	30.8	5.3
Lack of/loss of interest in science, mathematics, and engineering: "turned off by science"	5	1	28.9	48.9
Rejection of science, mathematics, and engineering careers/associated lifestyles	6	4	26.9	29.8
Inadequate high school preparation in basic subjects/study skills	7	10	25.0	10.7
Discouraged/lost confidence due to low grades in early years	8	6	23.1	22.9
Poor teaching by science, mathematics, and engineering faculty	9	2	21.1	42.0
Curriculum overloaded, fast pace overwhelming	10	3	19.2	41.2

SOURCE: Seymour and Hewitt 1994, p. 373.

Choosing and Leaving Science in Four Highly Selective Institutions

A study seeking to discover some of the causes of initial interest in—and attrition from—the natural sciences and engineering among 5,320 students entering Brown University, Cornell University, Dartmouth College, and Yale University in 1988 found that, except for women's dislike of competitive educational environments, gender had little impact on either choice of or persistence in most science and engineering majors. In mathematics and computer sciences, women did persist less successfully than men (Strenta et al. 1994, p. 513, 528). Nonetheless, "in every field of natural science and engineering, *once science grades in the first two years were taken into account*, gender was not a factor in persistence" (p. 529, italics added).

The study also found that, although 35 percent of women compared with 49 percent of men expressed initial interest in science, "once preadmission measures of developed abilities—[test scores and science grades]—were taken into account, …gender added little" to such a choice (1994, p. 513). Of the 2,276 students initially interested in science (from a pool of 5,320 matriculants at the four institutions), 40 percent eventually dropped out, and smaller proportions of women (48 percent) than men (66 percent) persisted. The "most significant cognitive factor" for both men and women predicting attrition was poor grades in lower division science classes. With grades held equal, women stayed in their biology, engineering, physics, and chemistry majors as often as men; "gender added strongly to grades, however, as a factor" leading to high attrition in certain other science fields (p. 513, 528).

Science majors responding to a questionnaire administered in 1991 showed that many of them find the instruction to be "too competitive," to offer "too few opportunities to ask questions," and to be provided by professors who "were relatively unresponsive, not dedicated, and not motivating" (p. 513).

Although most of the students who left science and engineering did so because of the positive attractions of other fields, many criticized the coursework as too hard, the instruction as inferior, and the atmosphere as excessively competitive. Except for the latter perception, women's classroom experiences were rated about as unpleasant as men's.

To encourage more women to enter science, the study recommends providing

- confidence-building exercises such as research assistantships and mentors
- advice to secondary schools as to what preparation is necessary
- "a grading system whereby talented and hard-working science students have at least the same chance of earning decent grades as all other students have" (p. 544)

The researchers also believe one approach to be "counterproductive: Namely, to emphasize the unproven allegation that science faculty are making the lives of women in science especially unpleasant" (p. 544).

Michigan; the University of California, Los Angeles; the University of Illinois at Urbana–Champaign; and the University of Wisconsin, Madison. Joining this group among the top 10 baccalaureate institutions of female science and engineering PhDs during this period were Pennsylvania State University; the University of California, Davis; the University of Maryland; and Rutgers University (New Jersey). (See appendix table 3-21, and for other institutions producing significant numbers of female doctorates in science and engineering, see appendix table 4-25.)

Minorities

Some colleges and universities educate a disproportionately large share of undergraduate members of racial/ethnic minorities. For example, America's historically black colleges and universities[14] continue to play an important role in the production of bachelor's degrees earned by blacks, despite the growing diversity of the Nation's campuses. Hispanics are most likely to attend colleges and universities in regions of the country where they form a large percentage of the population: California, Texas, Florida, and Puerto Rico, cultures where they sometimes are not a minority. (See NSF 1994, pp. 245–246.) And a significant percentage of American Indians also study at institutions in regions of the country where they are concentrated by population:

[14] Of the more than 150 postsecondary institutions founded during the years of legal segregation, 106 were open in 1994. Located largely in southern and border states, most offer baccalaureates—19 provide associate degrees only and a handful, graduate awards (Trent and Hill 1994).

A Burden of Suspicion: How Stereotypes Shape the Intellectual Identities and Performance of Women and Blacks

Claude M. Steele's research on the "troubling lack of persistence of women in advanced quantitative fields and the underperformance of African Americans in schooling more generally" (1995, p. 2) has led to his theory that "stereotype threat" and "disidentification" are possibly among the causes of these academic failings.

Steele defines stereotype threat as "apprehension over possibly self-fulfilling negative stereotypes about one's group or about being judged" in their terms (p. 2). He summarizes, "This threat amounts to a jeopardy of double evaluation: Once for whatever bad thing the stereotype-fitting behavior or feature would say about anyone, and again for its confirmation of the bad things alleged in the stereotype" (p. 12). His research shows that taking difficult standardized tests in subject areas in which their abilities are "negatively stereotyped" can threaten able women and blacks, and that this state "dramatically depresses their performance" (p. 2).

Laboring under such negative stereotypes can "frequently cause school disidentification"—that is, women and/or blacks can drop out and/or refuse to internalize subjects they think the majority expects them to fail. Notes Steele,

> I did this with the baritone horn in the eighth grade. After the band instructor told me, as I was going on stage with the band, that I could hold the horn but that I didn't have to play [it], I began to realign my self view so that competence on that horn would not be an important basis of my self-esteem. I looked for other identities…. This normal process of identity formation and change can be pushed into use as a defense against the glare of stereotype threat. It is, of course a costly defense,… [which may] undermine the capacity for self-motivation that is part of having an identified relation to a domain (p. 4).

Steele elaborates through reference to William James's description of the development of the self as a process of picking from the many possible those "on which to stake one's salvation" (cited in Steele in press). Once a self has been identified with, overall esteem "becomes hostage to it in that success in the domain makes one happy." To illustrate, James admitted he would be "sad to learn that someone knew more psychology than he, but that he could 'wallow in the grossest ignorance of Greek'" (cited in Steele in press).

Steele and his colleagues support their theories about stereotype threat and disidentification with regard to women and mathematics through altering the instructions under which men and women took the *same* difficult test: "Women performed worse than men when they were told that the test produced gender differences… but they performed equal to men when the test was represented as insensitive to gender differences. With Joshua Aronson, Steele experimented with black and white students on another *single* test, also difficult, of verbal ability. When the test was presented as a test of intellectual ability, blacks responded by underperforming. When it was said to be "ability nondiagnostic"—as a problem-solving task unrelated to ability—black and white performance was equal (p. 22). In another test, when blacks were asked to list their race, they again underperformed whites; the two groups' performance was about equal when the race question was not asked.

Studies and programs designed by Steele and others show that "wise" educational environments (p. 29) can overcome both stereotype threat and disidentification. Stressing that "stigmatization is situation-specific, less something that marks a person across all situations than something that—stemming from specific negative stereotypes—devalues groups in specific situations," Steele recommends

- optimistic student-teacher relationships
- nonjudgmental responsiveness
- imputing ability
- challenge, not remediation
- stressing intelligence's expandability
- group study

Following these principles, Steele and his colleagues implemented a program at the University of Michigan that reversed most of the underachievement patterns and high dropout rates of black first-year students. Concludes Steele:

Predicaments like [stereotype threat and disidentification] can be treated, intervened upon, and it is in this respect that I hope the perspective taken in this analysis offers hope, and some early evidence, that solutions to these problems may be closer than we have recognized (p. 38).

Oklahoma, California, and Texas. (See NSF 1994, pp. 249–251.)

Thirty percent of the black students who received bachelor's degrees in science and engineering in 1993 earned them at historically black colleges and universities, up slightly from 29 percent in 1985. (See appendix table 3-22.) Engineering was responsible for most of the gain. The fraction of engineering degrees to blacks from historically black colleges and universities increased from 22 percent in 1985 to 27 percent in 1993. Change varied across fields: in physical sciences, the percentage of blacks earning bachelor's degrees at historically black colleges and universities rose between these years from 44 to 47 percent, whereas in mathematics the percentage fell slightly from 50 to 48 percent.

"The 80 [historically black colleges and universities] which award bachelor's degrees in science and engineering are a small proportion of the total number of institutions in this country which award [such degrees], yet they play a prominent role in educating African-American scientists and engineers" (Trent and Hill 1994, p. 72). Between 1986 and 1988, historically black colleges and universities were the baccalaureate-level institutions of 29 percent of blacks earning doctorates (p. 77).

Students With Disabilities

Undergraduates with disabilities attend colleges and universities of all types in all parts of the country. Some enroll at disability-specific institutions or ones with programs designed particularly to assist students with a particular disability. The only dedicated, federally funded institutions serving persons with particular disabilities are two institutions for deaf and hard-of-hearing stu-

Minorities in Science at Four Highly Selective Institutions

Another study of science and engineering majors[15] at the four highly selective institutions considered in the box on page 36, this time focusing on non-Asian minorities—except for American Indians—finds that, unlike women, minorities are "*at least* as interested in pursuing science as whites" (Elliott et al. 1995, p. 1). The researchers conclude that "the chief problems for non-Asian minority students aspiring to science majors would appear to be not institutional racism, but rather a relative lack of preparation and developed ability" (p. 40).

"Despite relative deficits in scores on measures of preparation and developed ability, blacks entered college with strong interest in majoring in science," they write (p. ii). Blacks had the highest attrition (66 percent), however; whites and Hispanics were near the average of 40 percent; Asians were lowest (30 percent). The researchers also found that ethnicity "did not add significantly to ability and achievement variables in predicting attrition," and they uncovered "almost no evidence of any sense of racial or ethnic discrimination" (p. ii).

Responses of students originally intending a science and engineering major suggest that ethnicity did make a difference, however, in a number of areas, including background, budgeting of time, reasons for attrition, and attitudes toward the academic environments of their majors. "If equal developed ability predicts equal persistence, unequal developed ability predicts differential persistence," and whites and Asians typically have better science and mathematics preparation than underrepresented minorities (p. 4). "Hispanics appear to have persisted more, and blacks less, than [high school test scores and science grades] might have indicated" (p. 13). Still, "preadmission variables accounted for a significant fraction of the variance of persistence decisions, and ethnicity did not" (p. 13).

"The gap in developed ability between the white-Asian majority and non-Asian minorities, especially blacks, especially in science, results from institutional policies of preferential admissions from pools differing in measures of…achievement at the point of entry into higher education" (p. 35). Underrepresented minority students may decide that the cost, however serious, is worth the education they receive. But selective majority white institutions could usefully assist underprepared minority students in a number of ways, including

- offering voluntary intensive mathematics and science courses to students interested in science with Scholastic Aptitude Test mathematics scores below a certain level
- encouraging during this period the growth of a community
- linking students with mentors
- providing internships
- and—as for women—encouraging group study and providing advice to high schools about what preparation is necessary.

[15] The sample was 3,534 whites, 582 Asians, 355 blacks, and 216 Hispanics enrolled in 1988. Researchers excluded American Indians from the analysis because of the small numbers involved—of the 34 matriculating, only 9 expressed an initial interest in science.

dents—Gallaudet University (Washington, D.C.) and the National Technical Institute for the Deaf (New York). Both receive substantial Federal funding; the U.S. Government also supports four programs for deaf and hard-of-hearing students within postsecondary institutions serving all students.[16] About half of the Nation's undergraduate institutions, however, enrolled at least one student who self-identified as deaf or hard of hearing between 1989 and 1993 (U.S. Department of Education, National Center for Education Statistics 1994).

At all educational levels, students with disabilities may request and can receive accommodative support from individuals, programs, offices, policies, and equipment designed to give them equal access to educational opportunity. A number of colleges and universities advertise assistance to students with learning disabilities, the fastest growing group among students with disabilities, to enable them to learn in regular campus curriculums.[17]

Supportive educational environments comprising help and encouragement from family members, friends, teachers, other persons with disabilities—mentors, advocates, and advisers—are the "most important factors encouraging students with disabilities to progress in science and engineering (or any field)."[18] Nonetheless, recent strides forward in assistive technology, which often break down centuries-old barriers to access, "have really exploded in certain fields. Perhaps the most important of all has been the computer. People with disabilities who previously might have been unable to be active in certain disciplines now can—because computer literacy is bound to be involved somewhere" (Stern, quoted in Timpane 1995, p. 1796).

Not only is technology improving assistive devices for individuals with disabilities, but also recent legislation, particularly the Technology Act of 1988 (reauthorized in 1995), has increased access to such technology. (See appendix A Technical Notes on "Information on Persons With Disabilities" and appendix table 1-1.)

[16] Gallaudet enrolls students at all undergraduate and graduate levels, whereas the students at the National Technical Institute for the Deaf can earn certificates, diplomas, or associate degrees, often then transferring to its enfolding university, the Rochester Institute of Technology, or elsewhere for baccalaureate and/or graduate study. In addition, a number of institutions provide special programs for deaf and hard-of-hearing students: the California State University at Northridge has federally funded programs at all degree levels; the Postsecondary Education Consortium (Tennessee) offers undergraduate degrees and below; the Seattle Community College (Washington) and the St. Paul Technical College (Minnesota) give associate degrees.

[17] College directories list many institutions with programs to enable such students to participate in regular coursework. (See, for example, Mangrum and Strichart 1994, and Kravets and Wax 1995.)

[18] Virginia W. Stern, Director of the American Association for the Advancement of Science Project on Science, Technology, and Disability (Washington, D.C.), personal communication, 25 October 1995.

The Opposite of Attrition: Switchers *Into* Science and Engineering

Although many adolescents *lose* interest in science, mathematics, and engineering after the sophomore year in high school, data also indicate that a significant number *switch into* those fields during their undergraduate years. Analysis of longitudinal data examining interest and enrollment over time show that:

> Nearly 60 percent of those who eventually went on to major in [science, mathematics, and engineering] had no plans to do so when they were high school sophomores. Indeed, nearly as many students decided to major in [science, mathematics, and engineering] after their sophomore year of college as stayed with a decision to major in [these fields] as high school sophomores. This finding suggests that educators concerned about the development of scientists, mathematicians, and engineers for the future need to look to other fields and help smooth the transition of students from one major to another (NSF 1993, p. 13).

More men immigrate into science fields than do women, according to Strenta et al. (1994). Ninety-five women and 165 men switched into science between 1988 and 1992 at the four highly selective institutions they studied (p. 525). The recruits are often strong students: they "averaged 3.24 in their science courses during the first two years, while students who were initially interested in but left science had a corresponding average of 2.63" (p. 526).

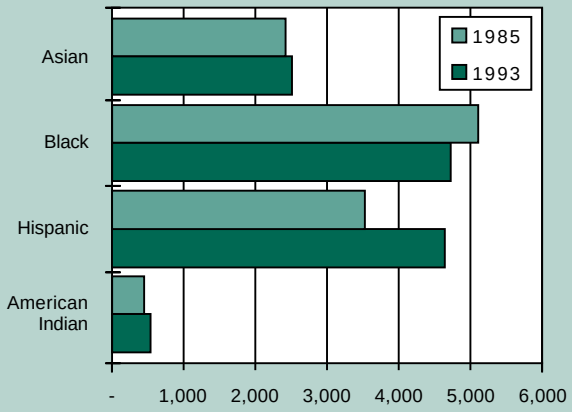
Graduation: Degrees

Associate Degrees and Certificates

Associate degrees offer one measure of completion for courses of study below the baccalaureate. All higher education institutions may award associate degrees; however, they usually complete courses of study only in 2-year colleges, and many students who do preliminary work there choose to transfer to baccalaureate-and-above institutions without earning degrees. Hence, dropout rates for 2-year institutions often lack the significance of attrition before the baccalaureate—failure to reenroll may mark an educational transition forward rather than a loss.

More than a third of the students who eventually go into science and engineering fields begin their education in 2-year colleges. (See appendix table 3-17.) Just under a third of these students in 2-year colleges transfer after earning an associate degree; more than two-thirds go on without one. The number of students earning associate degrees in science and engineering fields declined between 1985 and 1993; over 16,000 fewer degrees were awarded in 1993. American Indians, however, con-

Figure 3-8.
Associate degrees to minorities in science and engineering, by race/ethnicity: 1985 and 1993



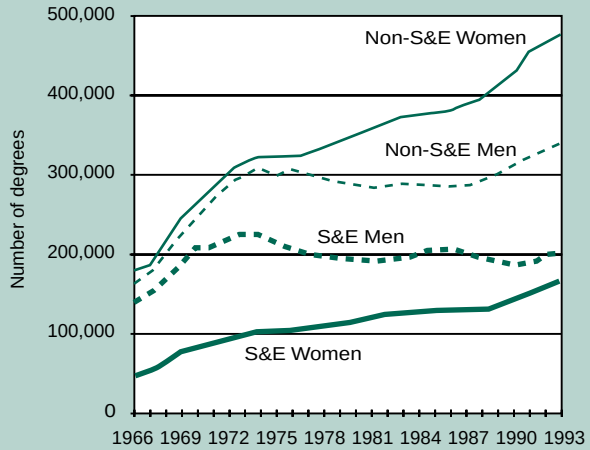
See appendix table 3-23.

tinued to earn an increasing number of associate degrees. (See appendix table 3-23 and figure 3-8.)

In 1993, underrepresented minorities earned 9,900 associate degrees in science and engineering (16 percent), up from 9,076 in 1985 (12 percent). (See appendix table 3-23.) They were more highly represented in some fields than in others. In the two fields awarding 77 percent of the science and engineering associate degrees, however—computer science and engineering technology—they earned only 22 percent and 14 percent, respectively.

Women made up almost 47 percent of students earning associate degrees in 1993, excluding engineering technology (the most populous science field at this level). Including the 38,473 degrees in engineering technology, women's representation sinks to 25 percent. Minority women tended to follow the pattern for all women, but percentages are higher for those underrepresented.

Figure 3-9.
Bachelor's degrees in science and engineering (S&E) fields and in non-S&E fields, by sex: 1966–1993



See appendix table 3-26.

Baccalaureate Degrees

In 1993, 1,179,278 bachelor's degrees were awarded in all fields. Women received more than half of the total number, as they have since 1982. (See appendix table 3-24.) Their share has continued to increase; by 1993, women earned 641,742 bachelor's degrees (or over 54 percent). Of the total baccalaureate degrees awarded that year, 31 percent were in science and engineering fields. (See appendix table 3-25.) In those fields *combined*, women earned 45 percent of the bachelor's degrees granted in 1993, up from 25 percent in 1966. (See appendix table 3-24 and figure 3-9.) In the combined science fields *alone*, however, women earned more than half the degrees (51 percent).

In most science and engineering fields, the fraction of degrees going to women increased between 1983 and 1993; however, women earned fewer than half the bachelor's degrees in all these fields except in psychology—where their representation went from 68 percent in 1983 to 73 percent in 1993—sociology (68 percent) in 1993, and biological science (52 percent). (See appendix table 3-26.)

The proportion of women declined between 1983 and 1993 in three fields. The proportion of women earning bachelor's degrees in computer science decreased from 36 percent in 1983 to 28 percent in 1993; in economics, the percentages slipped from 32 to 30; and in sociology, the percentages decreased from 70 to 68. On the other hand, women went from 12 percent of the oceanography degrees in 1983 to 27 percent 10 years later. Women earned more baccalaureates in mathematical sciences than in 1983 but fewer in computer sciences.

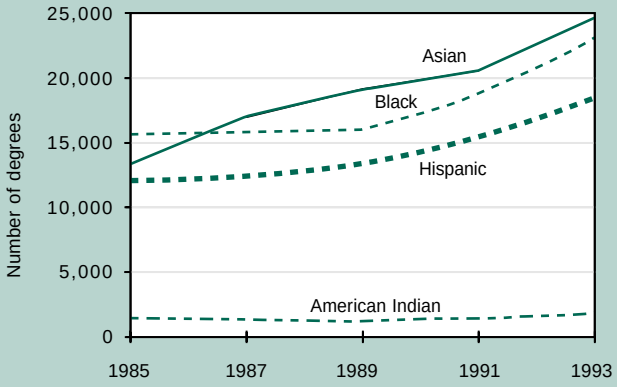
Women earned low but growing proportions of engineering degrees (going from 13 percent to 16 percent over the decade) and earth, atmospheric, and oceanic sciences (from over a quarter to under a third of the field). (See appendix table 3-25.) For men, on the other hand, engineering was the second most popular field, trailing social sciences in number of degrees awarded. Women made the biggest gains in chemical engineering (from 21 percent to 32 percent) and in civil engineering (from 14 percent to 18 percent). (See appendix table 3-26.)

In 1993, U.S. citizens and foreign students on permanent visas earned 1,122,276 bachelor's degrees. Underrepresented minorities earned roughly 12 percent of all bachelor's degrees, the same percentage they earned in science and engineering combined. The number of degrees awarded to blacks, Hispanics, and American Indians has been rising. (See figure 3-10.) In 1993, underrepresented minorities earned 41 percent more bachelor's degrees in nonscience and engineering fields than in 1985. The proportion rose faster in science and engineering—they earned 47 percent more degrees than they did 8 years earlier.

In the last decade, although all minorities have steadily increased their share of bachelor's degrees in science and engineering,[19] important differences *among* groups and, by gender, *within* minorities are evident. (See text table 3-3 and appendix table 3-28.) Although Asians' share of bachelor's degrees was greater than their proportion in the population, blacks, Hispanics, and American Indians continued to be underrepresented. Asians, who constitute 3 percent of the population according to Census Bureau data, earned 7 percent of science and engineering baccalaureates in 1993. Blacks (about 12 percent of the population) also earned 7 percent of the degrees.

In 1993, women earned 108,958 more baccalaureates than men (5 percent), and they also earned the majority of degrees in science fields. Underrepresented minority women continued to earn more degrees than black, Hispanic, and American Indian men. So few minority women earned engineering degrees, however, that they remained underrepresented among students achieving baccalaureates in science *and* engineering combined.

Figure 3-10.
Bachelor's degrees to minorities in science and engineering fields, by race/ethnicity: 1985–1993



NOTE: Data are for U.S. citizens and permanent residents only.
See appendix table 3-27.

Text table 3-3.
Percentage of science and engineering bachelor's degrees earned by women, by race/ethnicity—U.S. citizens and foreign students on permanent visas only, 1993

Race/ethnicity	All baccalaureates	Science and engineering	Science	Engineering
All students	55	45	51	19
White	54	44	49	15
Asian	51	42	50	20
Black	63	59	62	32
Hispanic	59	50	56	21
American Indian	57	51	54	19

See appendix table 3-28.

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